

Spring 2013

# Fracking and Federalism: Analyzing Produced Water in Colorado, Texas, and Federal Entities

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Fracking and Federalism: Analyzing Produced Water in Colorado, Texas, and  
Federal Entities

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A thesis submitted to the  
University of Colorado at Boulder  
in fulfillment  
of the requirements to receive  
Honors designation in  
Environmental Studies  
May 2013

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## Abstract

Over the past decades, technological advances in natural gas drilling has allowed for nonconventional gas extraction. The new technology of combining vertical and horizontal drilling has sparked a gas boom in the United States. Though natural gas is seen as a cleaner solution to coal and dirtier fossil fuels, there has been an increased controversy over states ability to regulate the changing industry. Many environmentalists argue that HF is causing environmental damages while industries have denied such allegations. States and local governments have scrambled to keep up with the gas boom and public concerns have risen sharply. This article is policy neutral and analyzes whether or not hydraulic fracturing should be federalized. Texas, Colorado, and federal entities such as BLM land and Coastal Zones will be compared for environmental regulatory protection, enforcement capabilities, and number of violations. For analytical purposes, produced water was the only process analyzed. The results concluded that there are transparency issues and wide inconsistencies between states. Due to the wide variety in access to information, number of inspections, and violation data, this study suggests that the federal government should take a bigger role in hydraulic fracturing, but full federalization would be inefficient because of regional differences.

## Preface

The subject, hydraulic fracturing, began to interest me last summer when I began reading literature on the matter. My father also increased my interest when he began to rave about fracking and how it was “ the biggest thing to happen to oil & gas companies in decades.” As an Environmental Studies major, with a minor in Political Science, I immediately became intrigued with the regulatory methods of fracking and decided to pursue my thesis on fracking. I grew up as an expat, living in six countries, because my father worked for Chevron. I have always been surrounded by and familiar with the oil & gas industry, which is a major reason why, I chose a major in environmental studies as well as my thesis topic.

This study began with broad question of, whether hydraulic fracturing should be federally or state regulated? It later became narrower and developed to specifically analyze produced water in Texas and Colorado along with federal entities such as BLM land and Coastal Zones. This study is policy neutral and is intended to logically compare pro state and pro federal arguments.

This project could not have been done without the support of my father, interview by Craig Brown, and that of my advisors: Dale Miller, Steven Vanderheiden, and William Boyd. Thank you all for your guidance in this process.

## **Introduction**

The extraction of oil and gas from shale rock has exploded in the United States. Due to new technological advances, the once unattainable gas reserves have become open for cheap development. The oil and gas industry has innovated and adapted to changes as demand for energy increases and supply decreases. Offshore drilling was thought to have been the answer, but that sector has proven to come with high risks, seen in the BP oil spill. It is apparent that the once plentiful reserves are getting increasingly more expensive to extract (Willie, 2011) and terms like “Energy Independence” are on the minds of Americans. Hydraulic fracturing could very well hold the answer to short-term “Energy Independence” and will be at the forefront of energy topics and laws. Though hydraulic fracturing, also known as “Fracking,” is both lucrative and has economic benefits in a time of low employment, the controversies surrounding this practice are abundant and it is hard to pinpoint what regulatory approaches the United States should take.

Environmental groups and the public have grown increasingly concerned over the environmental risks of fracking and have pushed for augmented federal oversight as well as the removal of regulatory exemptions for fracking. The gas industry has pushed against federalization, arguing that state-level regulations are comprehensive and have protected the environment adequately. The answer is in a hybrid approach for state and federal cooperation.

This study will analyze whether hydraulic fracturing should be federally regulated or remain at the state level, particularly looking at produced water regulations in Texas, Colorado, and Federal Entities. The regulatory advantages and disadvantages at the federal and state levels will also be compared. Due to the wide variety in access to information, number of inspections, and violation data, this study suggests a hybrid approach where the federal government should take a bigger role in hydraulic fracturing, but full federalization would be inefficient because of regional differences.

## **Chapter 1: Background**

### **Methods**

This report will compare produced water regulations and violations/enforcement in Texas, Colorado, and federal land. Due to the controversy surrounding water issues, produced water was chosen as it is exempted from RCRA and is known to cause environmental damages. Texas and Colorado were chosen because of their similarities but also because of their differences. Both states have a long history with the oil & gas industry and are both affected by hydraulic fracturing. They differ in regulatory agendas and information access. Comparing the three agencies will show if there is significant variation in violations and regulations. For example, if one state has fewer environmental regulations and higher violations than another state, that may suggest that minimum regulation standards should be set for every state. Once the data is collected, the pros and cons of federal and state regulation will be analyzed and recommendations will be made.



### Background Information

The recently released IEA report states that the United States will surpass Russia by 2015 and Saudi Arabia by 2020 as the world's largest gas and oil producer ("US to become," 2012). By 2020, the US will be a new exporter of natural gas and will "almost be self-sufficient in Energy" by 2035 ("Us to become," 2012). Though Saudi Arabia will surpass the United States again in 2035, the US will still be a big market player ("US to become," 2012). In 2011, 94 % of all natural gas was produced domestically and in the beginning 6 months of 2012 the United States met 83% of its energy needs ("Us to become," 2012). It is easy to see why hydraulic fracturing is extremely important to the US economy and future energy policy. As debates begin over how this gas boom should be dealt with, issues such as environmental impacts, employment prospects, price control, water rights, energy security, and regulations will all play roles in deciding our nation's future policies.

### What is "fracking"?

Hydraulic fracturing has been around since the 1940s. The first frack job was completed in Kansas and was very inefficient and hazardous (Willie, 2011). Now, with newly introduced technology there have been over a million "fracks" in the United States and the number continues to rise. Today, "fracking" is present in every gas-producing state and near metropolitan areas (except New York), such as Colorado, Wyoming, Oklahoma, Texas, New Mexico, Pennsylvania, Indiana, and North Carolina (Willie, 2011).

Hydraulic fracturing is a process of pumping fracture fluids consisting of mostly water and sand along with chemical additives (gelatin and much more) at a

high enough pressure to cause fractures in the rocks to release the oil and gas. Gas shales are fine-grained rocks that store significant amounts of gas. Once the fracture fluid is injected, the produced water is brought back up to the surface for disposal. This technique is for “unconventional” gas sources such as tight sands, coals beds, and deep shale that were thought to be unreachable. Oil and gas companies are able to extract shale gas through the combinations of vertical and horizontal drilling that can drill greater than 8000ft ("Hydraulic fracturing research," 2010), greatly increasing extraction surface area. Below is a diagram that sums up the process: (Manuel, 2010)

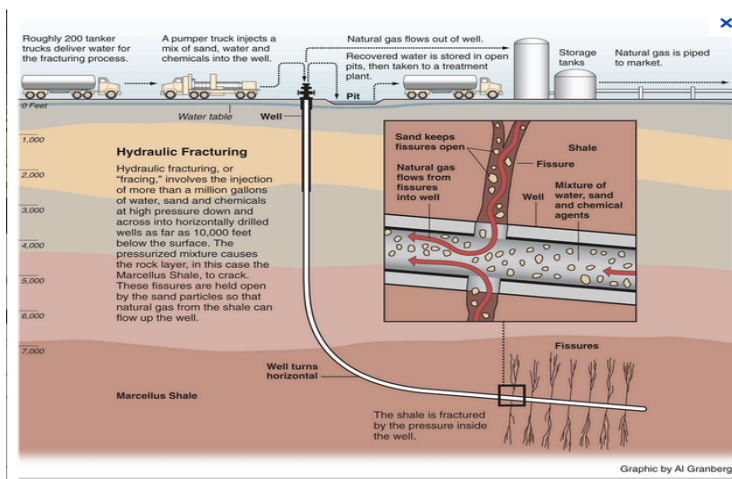


Figure 1 Fracking Overview

Before a frack job begins, companies perform a series of tests to ensure that the infrastructure can withstand the pressure (Willie, 2011). Every frack job is different because underground formations vary from region to region and state to state. The introduction of horizontal drilling and continued innovation and development will allow for harder to reach gas extraction to support rising demand.

### Water rights of Texas and Colorado.

Hydraulic fracturing is water-intensive (see waste management and water use section) and the produced water that is pumped back from the well is usually not recycled and stored in pits and old wells, making this process water wasteful. In order for the federal government to regulate HF, they will need to understand the water laws of each state. Western water laws are more complex and different than those in the East as water is relatively scarce and hard to find in the West. The extraction of water upstream affects those who wish to use the water downstream, thus creating the need for unique water laws that are not seen in eastern states. States West of the Mississippi River have been developing water laws since the early settlers, and water rights that were administered a century and a half ago are precious and vital to farming, cattle ranching, and the oil/mining industries (Grantham, 2011). Today, water rights result in many lawsuits as Colorado ranchers and oil & gas industries fight over water use. Obtaining and keeping water rights (senior and junior) cause so many problems that there is a Colorado supreme court designated for water issues.

Despite the lack of rainfall, Colorado is blessed with the Colorado River that is fed by the Rocky Mountain's snow and glaciers. The Colorado River supplies water to six states and some parts of Mexico. As a result of interstate boundaries, stringent water rights are applied to every aspect of water collection. For example, permits are required for surface water extraction, underground water, rain collection, wells, and dam construction. Due to the complexity of Colorado water laws, this section will briefly touch on water permitting systems specific for well

drilling and hydraulic fracturing . Colorado law states that you may retain your water rights so long as the water is used “beneficially.” The court ruling, on April 20<sup>th</sup> 2009 *Vance v. Wolfe* determined that the water used to extract Coal Bed Methane from tributary groundwater is for beneficial use and therefore do require well permits (Grantham, 2011). In cases of non-tributary underground water, which is water that is not connected to surface flows; the oil and gas industry is not required to have a water replacement plan (Grantham, 2011). For all non-Coal Bed Methane extractions, no permit is required. In Colorado, water supplies can be sold and put up for auction, causing tension between ranchers and the gas industry as they fight for water access. If drought conditions persist in Colorado and Texas, water law will need to be updated to keep up with water conservation in the west as urban, agricultural, livestock and the gas industry compete for the finite resource.

Texas is different than Colorado in that groundwater belongs to the landowner, while surface water belongs to the state (Kaiser). Groundwater can be pumped regardless of its effects on neighboring landowners. Texas water law is known as “the law of the biggest pump,” meaning groundwater can be used and sold as private property. The recent Texas Supreme Court Case of *Edwards Aquifer Authority V. Burrell day and Joel McDaniel* , February 17<sup>th</sup> 2010, reaffirmed that landowners own the water below their property and landowners can be owed compensation if local or state governments restrict their use of water (Buchele,2012). This is an interesting case because it does not address water conservation problems as Texas is in the midst of a big drought. This policy will allow landowners to sell and pump more water without any state limitations

(Buchele, 2012). Due to the fact that water is treated as private property, landowners can sell water to oil and gas companies. Texas is also experiencing a gas boom and the gas industry is moving rapidly to buy up water. Once Texas mineral rights are leased, oil and gas companies have the right to extract water without the consent of the landowner (Buchele, 2012). In Texas, there is no incentive to preserve water because landowners fear that the wells will dry up before they will be able to use and sell the water. This causes a “Tragedy of the Commons” situation, where a finite resource is over extracted because individuals act with their own interests in mind (Hardin, 1968).

There are many environmental concerns that come with hydraulic fracturing but water use and waste management are two of the more controversial areas of HF. Water in the West is scarce, highly valued, and is essential for all aspects of civilization from urban uses, agricultural and livestock to oil and gas extraction. As water becomes scarcer, tensions will rise and new regulations will need to be put into place.

### **Why Texas and Colorado?**

Since 2000, there has been a push for more research and regulations and the exemptions from the Safe Drinking Water Act (SDWA) and the Underground Injection Control (UIC) (unless the fracture fluid contains diesel) in the 2005 Energy Policy Act, make this a contentious political battle. In 2004, the EPA released a study stating that there was no direct evidence that hydraulic fracturing was a significant threat to public health. These results have been scrutinized and contested by many environmental groups and the EPA is about to release a new report in 2014.

As of now, hydraulic fracturing is regulated by the state and is not controlled by the federal government. Each state deals with “fracking” differently as they have different interests and experiences with oil and gas companies. States like Texas and Colorado have dealt with regulatory issues and the oil industry for decades, while states like New York and now North Carolina have little to no experience.

Colorado is known for its coal mining history and most of the towns that sprung up in the 1800s were because of coal resources and companies. Though coal remains a strong part of the economy of Colorado, shale gas has taken over as a cheaper and easier resource to extract because the federal government does not heavily regulate it. The Colorado Oil and Gas Conservation Commission (COGCC) determine oil and gas regulations. The COGCC, specifically to HF, controls issues such as chemical inventory, chemical disclosure, well casing and cementing, setbacks and precautions near surface waters and tributaries, monitoring pressures, requirements for Coal Bed Methane, pit permitting, spill notification, and wastewater management. The Colorado system, though lax, is known to be one of the more comprehensive regulatory states in the country and is commended for its chemical disclosure policy.

Through my investigation, Texas has a long history with the oil and gas industry and in some senses have laxer environmental regulations as well as barriers to information access. The oil industry has contributed to the economic growth and strength of the state. In Fort Worth alone, the city is expected to receive \$1 billion in natural gas revenues in the next 20 years and is expected to add \$ 6.5 billion annually to the Texas economy (Willie, 2011). HF is regulated by the Texas

Railroad Commission (RRC), which was established in 1891 to protect railroad workers from discrimination and underpay. It is the oldest state regulatory system in the nation and has been managing oil and gas extraction for 90 years. The RRC does not mention HF in their regulations, except for chemical disclosure (RRC, 2011), but does regulate hydraulic fracturing through its permit system; it just does not mention the name. Both states have extensive experience with hydraulic fracturing and have some similarities in water rights issues. Despite their similarities, Colorado has revised its statutes to comply with environmental demands more so than Texas. Comparing the two states will analyze the level of differences between them and help determine if there is a need for increased federal presence.

### Federalism

The United States was founded on the basis that “big government” was a threat to individual rights and liberties, with strong advocacy for state independence and rights. As a young country, the United States allowed each state to govern themselves, but as issues such as funding and paying off the debt from the costly Revolutionary War came into play, it was obvious that a stronger, central government was needed (ie. taxation authority). Early sources of federal power included the power to tax, interstate commerce, and foreign affairs (Kernell & Smith, 2012). As the US grew, states began to challenge central authority and threatened to succeed. Events like the Civil War, New Deal, Civil Rights, and the expansion and creation of bureaucratic institutions (Dept of energy, EPA, Education...) all expanded the power of the central government (Kernell & Smith, 2012). Issues such as gay

marriage, hydraulic fracturing, voting rights, immigration laws, marijuana legalization are all determined by the state. When the federal government decides to step in, it can cause tension and lead to Supreme Court cases. A great example that relates to Colorado is the legalization of marijuana. Here the state has voted to legalize and tax marijuana, while the federal government still holds that it is illegal. The law is in direct violation of federal jurisdiction and due to the Supremacy Clause, the Federal government (if it chooses too) can sue the state for violating federal law. In the case of hydraulic fracturing, the states are in control of regulating the process and have been for the past 60 years (Willie, 2011), it would be very difficult for the federal government to override state law and take control over the issue, unless there is sufficient proof that the state is not doing an adequate job.

The EPA and the Dept. of Energy are the federal agencies that would step in and take over the regulation of hydraulic fracturing. This would mean overarching rules for every state, funding for new infrastructure, research and employment, dealing with issues such as mineral rights and water rights (which vary from state to state), and find personnel that specialize in the field.

### **Local v State**

States and the federal government have been in conflict since their existences but the issue of Longmont has brought up another level of regulation, local v state. As hydraulic fracturing exploded in the state of Colorado, every city and regulatory institution had to frantically try to keep up with the gas boom. Longmont was not even discussed until the city decided to change their regulation in the November 2012 election, as HF expanded into their jurisdiction. The new city regulations



overstep state jurisdiction on regulating hydraulic fracturing and are thus being threatened by a lawsuit by the Oil and Gas Conservation Commission and the industry. Though the commission has been involved in similar court cases before, this is the first time in a long time that the commission is the plaintiff. Below are eight of the Longmont regulations that are in contention:

- A maximum limit on oil and gas site size.
- A 750-foot setback from occupied structures (existing or imminently planned).
- The city can determine when and where multiple wells could be drilled from a single location, and whether horizontal drilling techniques are appropriate to use.
- Wells must be set back from water sources such as streams, as well as from wildlife and wildlife habitat.
- Energy companies must comply with the city's wildlife protections, as well as state and federal requirements.
- Drilling in both existing and planned residential neighborhoods is banned.
- Energy companies must inform the city when hazardous materials are transported on city streets.
- Energy companies must use "low profile" tanks on well sites, or move them to a less visible area.
- Energy companies must go beyond the state's requirement for baseline water-quality testing and get the city's approval for a testing plan that lasts for five years.
- The city can determine whether or not its rules conflict with the state's rules. If there is a conflict, the city can issue a waiver to an energy company if they determine one is needed.

The two regulations that are the most concern to the commission is that the city requires water monitoring for five years and the city can ban drilling in residential neighborhoods (Keith, 2012). Though cities in the United States do hold some sovereignty, courts typically determine how much. Previous court cases in Colorado, determined that local jurisdiction could not outright ban drilling (Kindelspire, 2012). Both sides have valid points. The local government and people have every right to vote against something they do not want. The position that the state is taking is

threatening the home rule of the local government and will be an example to all local governments that try to challenge the state government. On the other hand, the state does have some valid points as well. The Colorado Oil and Gas Conservation Commission has years of regulatory experience and wants continuity within the state. If they were to let every city or county determine its own regulatory system, the state as a whole would suffer from bureaucratic inhibition and general inefficiencies on many fronts (Keith, 2012). It will be very interesting to see the results and how it will change the dynamic of state v local jurisdiction.

### **Environmental impacts**

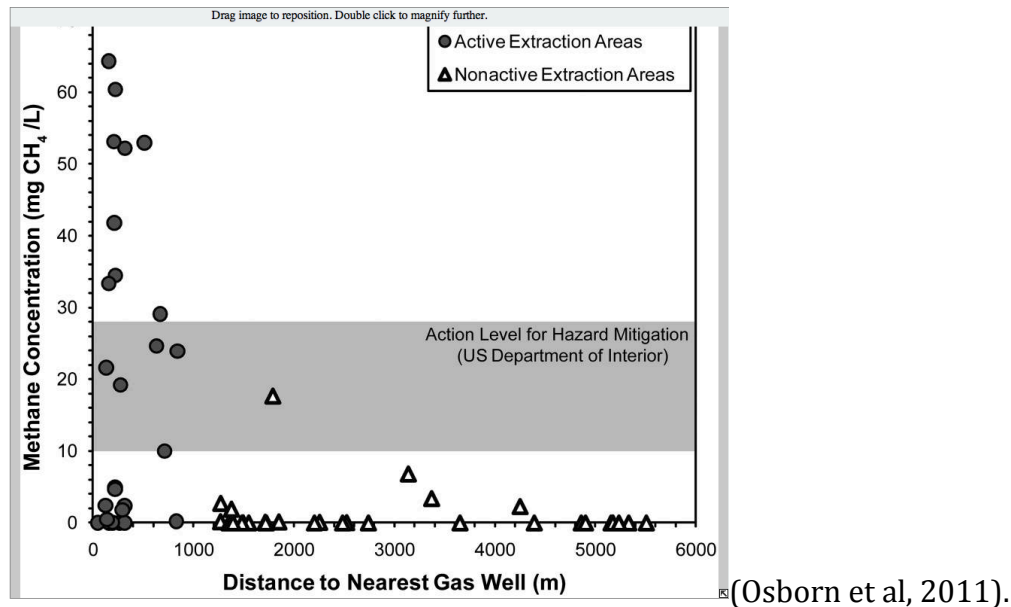
The assessment of environmental impacts on hydraulic fracturing is overwhelming. Concerns include: possible ground contaminations, air pollution, seismic activity, noise and quality of life pollution, water usage, waste management, and spills (Deutch et. al 2011). This section will attempt to address the most contentious aspects of “fracking.” Upon researching it is evident that the areas of most concern and controversy are water use and contamination. There are little disputes over the validity of seismic activity and air pollution. Due to the exemption of the SDWA, RCRA, and the UIC there has been little monitoring by federal agencies and most reports are deemed biased by both sides. This is a very conflict oriented section and produces heated arguments.

### **Underground Contamination**

The biggest threat to aquifers from fracking is leaks of fracture fluids and methane gas. Some wells are drilled thousands of feet below the aquifers, while others are alarmingly close. In 2011, a study was done in Pennsylvania and New York on

methane contamination and proximity to wells. Below is a graph demonstrating the increased methane concentration in relation to distance to active wells.

**Table 1 Methane Concentration Against Distance to Well**



There was some evidence that proved systematic methane contamination and proximity to wells, while at the same time there was no evidence of drinking water contamination for deep saline brines (Osborn et al, 2011). Though there was proof of methane contamination, the study suggested that more research is needed to make a decisive statement over the environmental impacts (Osborn et al, 2011). For this particular environmental impact, there is evidence of contamination, but not enough for it to be alarming nor enough to incriminate the gas companies. Methane and other compounds can leak into the environment prior to drilling and thus makes it difficult to prove liability. The 2004 EPA study did find proof of some contamination yet the federal government decided to exempt hydraulic fracturing from the SDWA and are allowed to inject fluids with no oversight (Willie, 2011). There is not enough information and systematic regulatory approaches to support

the claim that HF is or is not polluting groundwater. The federal government monitors industries if oil and gas companies decide to use diesel fluids in their “frack.”

#### **Air Pollution**

A study conducted by the Colorado School of Health found that those who live within half a mile from the wells are at higher risks for cancer and non-cancer health issues. The air pollutants of natural gas originate from inhaling xylenes, benzene, and alkanes, which cause eye, nose, throat, and lung irritation (McKenzie 2012).

#### **Wastewater management and water use**

Water, as mentioned above, is a vital part of the “fracking” process. Horizontal drilling is the most water intensive process of fracking- usually using five million gallons of water in each frack. Though this is an alarmingly high number, relative to other energy sectors, “fracking” accounts for about 1% of overall national water use (FracFocus, 2012). Nevertheless, its impact on local areas is still detrimental. A study of the water impacts of HF on the Texas Barnett shale is concerned that the combination of increasing population and random, sharp uses of groundwater for HF may be too much for groundwater recovery (Nicot, 2012). Hydraulic fracturing is expected to increase by 47% by 2035 and if the drought in Texas continues, there will need to be changes in water conservation (Nicot, 2012).

The EPA has split up the HF water use into 5 sections (EPA, 2012):



Figure 2 Stages in Water Use

Step 1 refers to water collection, whether it be from groundwater or surface water.

Step 2 is the process of mixing the fracture fluid, 95% of which is water and sand and 5% chemicals (EPA, 2012). The HF fluid is then pressurized and shot down vertically and even horizontally in order to release the gas. Stage 4 and 5 refer to flowback/produced water and wastewater management, which will be the focus of this study (EPA, 2012).

Like many other industries, gas extraction has to deal with waste disposal and management. Both Colorado and Texas have different infrastructure and deal with the situation differently. Once the fracture fluid is injected, flowback water is forced back up the wellbore to the surface. The contaminated, produced water usually contains high concentrations of salts, naturally occurring radioactive material, benzene, and magnesium (Jenkins, 2012). The produced water is then taken away for storage. The possibility of spills is of great concern so the wastewater should be disposed of properly.

Wastewater management varies from state to state due to the infrastructure of the state. Both Texas and Colorado dispose the majority of the waste in underground injection wells. These wells must adhere to the regulations of the UIC and are permitted by the state. The disposal wells that are used are known as class II wells. These wells inject fluids associated with the oil and gas industry, most of the

fluid is brine and chemicals that have contaminated the water. The most common used class II well is known as the Enhanced Recovery Well and make up 80% of the Class II wells (Class II, 2012). The states that use this waste disposal process the most are Texas, California, Oklahoma and Kansas (ClassII, 2012). Most underground injections occur in Texas because their geological and political regulations allow them to permit and license a lot more wells. Waste management becomes a lot more problematic for those who do not have access to these wells. Pennsylvania lacks class II wells and therefore need to contract companies and treatment plants to treat the water for reuse. Colorado disposes 60% of its wastewater in Class II wells, while 20% is recycled, and another 20% is put in evaporation ponds (GOGA, 2011). If produced water is under certain toxicity limits then it can be recycled and used for agriculture. Produced water can also be used again for fracking if it undergoes some wastewater treatment.

The environmental impacts of produced water include degradation of soils, groundwater, surface water, and ecosystems. One of the bigger threats to the environment is the dissolved ions also known as salts, hydrocarbons, and elements left over from the “frack” that, if improperly treated, can be harmful to the environment. Sodium is one of the common elements in produced water that compete with calcium, magnesium, and potassium for plant, root uptake. If the produced water is used for agriculture there is a risk of soil degradation and low crop production as the salts prevent water from seeping through the soils (Veil, 2012). Other threats include low aquifer contamination. The trace elements: boron, lithium, bromine, fluorine, and radium that are left over from the frack fluid also can

seep into soils and aquifers (Veil, 2012). These elements are typically found in sludge that is formed on oil equipment and nearby soils and pits, which are causes for human health and ecosystem concerns. Water consumption is also one of bigger concerns for produced water impacts. Impacts that are often overlooked are the transport of high volumes of water, large land disposal pits, pipeline and road infrastructure, and water hauling spills that cause erosion and impact the nearby ecosystem.

### Recycling

Recycling water is a relatively new practice for the oil and gas industry. Though it is not required by any state, recycling does reduce the amount of water used in the process. Recently, NPR discussed recycling produced water and it seems like the industry is leaning towards this approach because it is economically beneficial (Ashbrook, 2012).

Produced water if not treated, is unusable because it has high concentrations of Barium and Strontium (Grottenthaler, 2011). This makes produced water difficult to manage and store. Waste management is becoming increasingly difficult because of high trucking costs, lack of underground sites, and regional water shortages (Jenkins, 2012). Those researching recycling methods have to overcome the challenge of regional diversity. Every frack job is different and uses different chemical compositions (Jenkins, 2012). So an overarching method for recycling produced water will not be successful. Two major problems are the formation of Barium Sulfate and reducing the number of bacteria in the produced water. Technologies to clean up produced water include: oil-separators, dissolved flotation,

chemical oxidation, biological processes, filters, chemical separators, and ion exchange (Jenkins, 2012). Despite the challenges, industries and engineering companies are working on ways to increase the rate of recycling.

## **Chapter 2: Federal vs. State Regulations**

### **Introduction:**

Hydraulic fracturing will continue to grow in the country and as new wells are installed each day, regulating agencies will need to adapt in order to keep up. Although Hydraulic fracturing has been going on since the 1940s, it is not until recent years that the public has become concerned with environment and health effects. As the pressure mounts, environmental groups have asked federal agencies to step in and increase environmental regulations, while the oil and gas industry is lobbying to keep regulation at the state level. Regardless, regulating agencies must deal with inspection enforcement, regulating a changing industry, inconsistency between states in terms of regulations, water rights and shale formations, lack of transparency, and most importantly public perception. It is the public that has brought hydraulic fracturing into the media and congress.

### **Federal support**

Federalization, put simply, is to unite under central authority while still retaining certain residual powers. In terms of environmental federalization, federal agencies like the EPA, administers acts that contain minimum regulation standards for environmental protection. If the federal government were to increase oversight of HF, minimum and maximum standards would be put into place and in some cases violate Home Rule, which is why this debate is controversial. As of now, some



aspects of natural gas are exempted from RCRA, CWA, UIC, CERCLA, and “The Right to Know Act” (“Summary of federal,” 2012). Produced water is exempted from the definition of hazardous waste under CERCLA, it is also exempted from RCRA and “The Right to Know Act.” This means that regulation for hazardous waste is left up to the states. Colorado, Texas, and Pennsylvania have adopted their own means of waste management and in some cases have preserved the federal definition of hazardous waste (Logan et al., 2013). The EPA 2004 report and the Energy Policy Act of 2005 have contributed to the gas boom. The Energy Policy Act was a response to the 1997 decision to include fracking in the SDWA (Vikery, 2012). The attempted FRAC Act of 2009 and its reintroduction in 2011 to increase federal regulations have failed. This leaves produced water management up to the states. Chapter 2 will highlight the differences in produced water regulation in Texas, Colorado, and BLM land. These differences leave room for gaps in information and lack of transparency. Every state has different agencies, e.g. Colorado Oil and Gas Conservation Commission and the Texas Railroad Commission that have authority over hydraulic fracturing.

### Transparency

Overarching federal regulation would provide the public with much needed transparency and continuity (Logan et al., 2013). Finding information on fracking is difficult and time consuming. From personal experience, finding data on violations and BLM regulations were difficult and even resulted in no data collection. The lack of transparency increases suspicion of the oil and gas industry, which has already been accused of cover-ups and exploiting people around the world. Since the

environmental movement's landmark statutes of the 1960s and 70s were adopted, overarching regulations like the CAA, CWA, and ESA have successfully protected the environment. The need for a uniform national standard is greatly favored by anti-fracking agencies.

#### **Interstate boundaries /Externalities**

The justification for increased federal regulations is usually associated with interstate boundaries. If fracking externalities cross state borders and affect other states, then more federal regulations is needed. Determining the environmental impacts and evidence of interstate boundary pollution is uncertain. Regardless, those that will feel environmental impacts will be at the local level (Spence, 2013). When externalities fall primarily on local governments, these may not have the funds to regulate or protect themselves from environmental damages. A federal intervention would have the means and scientific capacity to research and regulate the situation (Spence, 2013). Since externalities tend to fall on local governments, those that bear the costs are outnumbered by those that receive the benefits; making it easier for states to form laxer environmental regulations if only a few are affected.

In contrast, local externalities often generate opposition among grassroots movements. It is the local people and stories that reach the media that spark large movements. Hydraulic fracturing can cause various forms of pollution from environmental degradation to noise and social pollution (Spence, 2013). Those local governments fortunate enough to have the means to ban fracking often attempt to do so. The current Colorado case involves the city of Longmont, which banished

fracking within its borders. The Not in My Back Yard (NIMBY) theory applies to this case. No one seems to want hydraulic fracturing in their neighborhoods, but unfortunately, it is the poorer neighborhoods that will not be able to fight it. There is no new information on the case and the ban was brought about by the Longmont Public Health and Safety Wellness Act ("Coalition acts to," 2013).

The most contentious interstate issue related to fracking is water. Water supply issues are typically handled at the state level, while some surface water is federally regulated. Water use and disposal that cross state lines are monitored by the CWA and through the Interstate Oil and Gas Compact Commission (IOGCC), but exemptions of the SDWA still leaves the majority of flowback regulation to the states (Vikery, 2012). The CWA prohibits direct discharge of wastewaters to surface waters east of the 98<sup>th</sup> meridian while west of the line discharge is permitted provided that it meets standards (Logan et al., 2013). With gaps in federal authority the IOGCC provides compacts between states to prevent cross boarder contamination. Many issues of water contamination are resolved through interstate compacts, where affected states voluntarily form compacts that in some instances are ratified by congress (Vikery, 2012). Though the IOGCC has 38 participating states, the commission is another lobbying agency for the oil and gas industry and has been pushing to limit the scope of the EPA ("Interstate oil and," 2013). The federal government should increase its role in interstate contamination by requiring federal officials to participate in compact contracts.

### Race to the Bottom

The “Race to the Bottom” hypothesis is not a new phenomenon and has been described by political scientists through game theory known as “The Prisoners Dilemma.” Game theory involves an exercise where two individuals would fare better if they cooperated, but because they do not know the decisions of the other individual; they act with their own best interests in mind, resulting in outcomes that are worse for both than would be possible with cooperation. HF applies to “The Race to the Bottom” hypothesis, which predicts that states will lower their regulations in order to attract businesses and compete with other states. The concept came around in the late 19<sup>th</sup> century and early 20<sup>th</sup> century, when states began deregulating for the auto industry, welfare, and cheap labor laws. An example of a “Race to the Bottom” effect can be seen in states exempting industries from certain taxes or allowing for more time to decommission wells. A recent periodical reported that in Texas, “gas production is taxed at a 7.5% rate, but special provisions in the tax code... have reduced many producers’ tax liability to zero” (Galbraith, 2013). As a result, the Legislative Budget Board of Texas is reviewing and considering whether tax exemptions should decrease. Looking at the data collected from Earthworks, there is a wide variation in the inspector to wells ratio and it is not far-fetched to say that some states are unprepared and lack budgetary means to keep up with enforcement needs. For example, Colorado has 15 inspectors that inspect around 1000 wells, while Ohio has 21 inspectors that inspect 499 wells, Texas has 88 inspectors per 1376 wells and New Mexico has 12 inspectors per 1732 wells. States with less budgetary capabilities are more prone to the “race to the bottom” hypothesis. If the federal government were to step in it should provide an

overarching regulatory program with funding so that states do not participate in risky-regulatory actions.

### **Arguments for state**

For 60 years, states have been controlling and monitoring hydraulic fracturing and have only recently been challenged by environmental groups to increase regulation to the federal level. Since 2009, public concern has increased dramatically and the media has begun to play a role in the nation's fracking hysteria. The 2010 movie "Gasland" sparked national concern over hydraulic fracturing. The numbers of new stories since 2009 around Houston and Denver have increased dramatically and so have the stories critical to fracking (Davis & Hoffer, 2012). Rising public concern has forced state entities to respond through the media against "overstated" environmental concerns. Fracking has become a conflict-oriented and contentious debate in which both sides have valid arguments. Support for keeping state regulation is held by industry trade groups such as America's Natural Gas Alliance, American Petroleum Institute and larger companies such as Chesapeake Energy, Halliburton, and the Interstate Oil and Gas Conservation Commission (Davis & Hoffer, 2012). Industries want the least amount of regulations and maintaining the status quo would insure that regulations do not increase. State advocates will argue that hydraulic fracturing should remain at the state level because states will take economic concerns, regional diversity, overstated environmental concerns into account, and are less bureaucratic.

## Economics

Over the years it is understood that the oil and gas industry has always been a lucrative business. The prospect of well-paying jobs in a weak economy has driven states to open their doors to hydraulic fracturing. In this context, environmental concerns are viewed as a luxury good, in that people will first focus on paying rent, feeding their family, and so on before caring about environmental impacts. In both Texas and Colorado, the oil and gas industry has provided the state with revenue that can be put towards public goods. Predictions from the Barnett Shale suggest that hydraulic fracturing could create 70,000 new jobs and add \$6.5 billion annually to the Texas economy (Willie, 2010). Fracking has also added thousands of jobs to Colorado, Pennsylvania, Wyoming, and the Dakotas (Stricherz, 2012). In Pennsylvania hydraulic fracturing brought \$389 million in state and local tax revenues and \$1.05 billion in federal taxes (Jacquelyn, 2010). Oil & gas exploration on BLM land has generated \$130 billion to the US economy (Wilson, 2012). Revenues from oil and gas extraction has gone to schools and even protecting wildlife. It is easy to see the economic power behind fracking. Many environmentalists will argue that money will keep states from protecting the environment, but Colorado has taken steps to revise and protect groundwater, while Texas has done little revision (Logan et al., 2013). States will work to protect their own economic interests more so than the federal government.

## Regional Diversity

Across the board, each state deals with hydraulic fracturing differently. In some respects, states will argue, that specialized/local regulation is better for environmental protection and industry efficiency. Each “frack job” varies and

requires different fluid makeup and fracking techniques as shale formations differ from county to county and state to state. Having an overarching regulation for fracking could increase environmental protection, do nothing, or be an unnecessary cost (Willie, 2010). For example, Colorado and Texas have very different shale formations that require different fracking techniques and disposal methods. States also already have the personnel that are experienced in their topographic regions as well as regulators who are familiar with the local and state laws.

#### *State familiarity and debates*

State entities are more familiar with their mineral laws, water laws, and regional differences than federal employees (Willie, 2011) and have been able to adapt and create legislative changes. Colorado has revised its regulations multiple times to become more environmentally stringent as public concern has increased. The externalities that are felt by hydraulic fracturing, like community character and water quality are held at the local level and local governments along with the state should be the ones regulating those issues (Spence 2012). Despite some regulatory lags, local and state governments are making changes to strengthen environmental regulation (Spence, 2012). Hydraulic fracturing is even contentious on the local level. For example, Garfield county has made a clear stance against federal regulations, La Plata county has mixed feelings, and Longmont is making a stand and banning fracking altogether (“Our Public Lands”). If the federal government were to take over, they would have to not only deal with state differences but also county differences. In the case of Longmont, the city challenged state authority and is now getting sued for banning fracking. The argument for state control is the same for

federalization- keeping fracking at the state level will prevent a “race to the bottom” county effect, meaning that if Longmont is able to ban fracking, then other counties will follow suit and those counties that are pro fracking will lower their regulations and allow more environmental degradation for economic benefits. If fracking was regulated at the local level, it is possible that some counties would under regulate to attract industries, causing a “race to the bottom” issue. This is the same argument environmental groups are using to push for federal regulations.

#### **Lack of Environmental Evidence**

Despite the fact that environmentalists are suspicious of hydraulic fracturing, some will argue that compared to coal mining, fracking is the lesser evil. Many environmental concerns are thought by pro-state and pro-industry to be exaggerated and not well supported (Willie, 2011). Most of this debate focuses upon the 2004 EPA report that gave hydraulic fracturing the approval stamp (Spence, 2012). The report was heavily scrutinized for lack of research and conflicts of interest. Shortly after the paper was published, an EPA scientist (Weston Wilson) stated that the:

Conclusions were unsupportable and that EPA decisions were supported by a Peer Review Panel; however five of the seven members of this panel appear to have conflicts-of-interest and may benefit from EPA's decision not to conduct further investigation or impose regulatory conditions. (EPA findings, 2006)

Though the report supports the argument for state level regulations, it is also a testament that politicians and lobbyist on Capitol Hill still, to some extent, control the EPA and are not to be trusted (Willie, 2011). This leads to bureaucratic failures and politicians who will stay partisan based regardless of scientific facts or what is



best for the state and the environment. In order to federalize fracking, there needs to be concrete environmental evidence that hydraulic fracturing is the cause of severe contamination. At the moment there is a lack of academic research proving that HF is the cause of major environmental damage (see tradeoffs section).

### **Bureaucracy**

Generally speaking, US citizens tend to distrust the federal government and have often complained about “red tape” and bureaucratic inefficiencies. Government inefficiency is not a new issue; there is threat of government shutdowns every time a big decision is to be made because politicians are unable to work efficiently together. Many departments do not communicate and have overlapping programs, which cause financial waste (Willie, 2011). The EPA requested \$4.3 million to research fracking in 2011; these expenses will not include how much it would cost for the federal government to take over as the main authority if fracking is federalized (Willie, 2011). The federal government would have to provide funds for new employees, be familiar with property rights in each state, and account for regional differences. Additional federal regulation would be costly for taxpayers and put financial burdens on developers (willie, 2011).

## **Chapter 3: Produced Water Regulations**

### **Colorado San Juan Basin**

The San Juan Basin is located in *The Four Corners* region shared by Colorado, New Mexico, Utah and Arizona. The region formed during the Mesozoic and Cenozoic time periods with sediment averaging 5000 feet in thickness in some locations. The basin itself spans 7500 square miles and holds both conventional and

unconventional reserves (Logan et al., 2013). The majority of unconventional reserves are located in The Fruitland and Menefee Coalbeds. Unconventional reserves include Coalbed Methane, which are shallower formations usually 1000 to 4000 ft. deep, compared to conventional gas wells that can go as deep as 10,000 feet ("Chapter 3," 2004). Historical accounts of methane seepage in the area have been recorded as early as the 1920s when farmers could light their water on fire and noticed the foul smell. Coalbed Methane (CBM) extraction began in the 1970s in La Plata County, a primary location for CBM extraction. Due to large extraction rates and the shallow wells, there is concern for methane seepage into the soil and water.

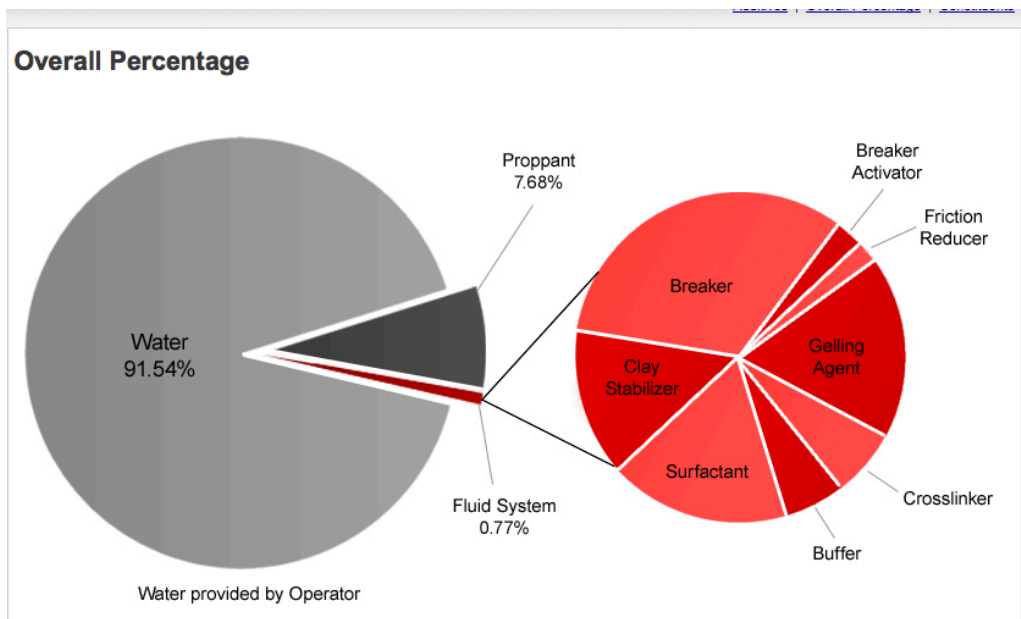
#### **Water usage in Colorado.**

As mentioned in the water rights section, Colorado has been appropriating water to its citizens since the early days of the settlers. Due to its long history of water appropriation, the majority of all surface water has already been distributed by the state and through water rights laws. Therefore, the main source of water for agriculture, cattle grazing, and the oil & gas industry cannot simply come from underground water sources or be diverted from a stream. The Colorado gas industry has several options for acquiring water, including: water transported from an outside state, leased irrigation, "raw water", and water treated at a wastewater treatment plant, as well as many other options for diverting ground and surface water with the owner's consent (COGCC).

The national average well uses about 5 million gallons of water per frack (fracfocus), an alarming number for most environmentalists. Though the amount of water used is alarming, it is important to note that water used by the oil & gas

industry only accounts for about 1% of total water used in the country- irrigation uses 37%. According to the Colorado Oil and Gas Commission, Hydraulic fracturing only uses .08% of the state's total water use. Despite this, dry states such as Colorado and Texas still face problems of regional drought as demand for water increases in all sectors of production including domestic use.

The general trend for water production in Colorado's La Plata county and San Juan basin for CBM gas production shows that as gas production increases, water production decreases per well (Logan et al., 2013). Nevertheless, the demand for water will rise steadily as new wells are formed. Every state conducting considerable fractures requires chemical disclosures from the oil & gas industry. Understanding what goes into the frack will determine some of the residues that come out in the produced water.



**Figure 3 Fracture Fluids**

("Haliburton-fluids disclosure," 2013)

These chemicals include those found in: soap, laundry stain removers, multipurpose cleaners, air fresheners, paint thinners and additives, photo developing agents, permanent markers, and food preservatives ("Haliburton-fluids disclosure," 2013). The flowback water will contain remnants of these elements along with naturally occurring elements found in the earth.

#### Produced Water Management in Colorado

Once a well has been "fracked" the majority of the flowback water returns to the surface in the first few days (100,000 gallons a day) and then slowly (50 gallons a day) for the remainder of the well's lifetime (Logan et al., 2013). Colorado, like every other state, has its own means of dealing with flowback water. The Colorado Oil and Gas Conservation Commission has listed its regulations pertaining to wastewater management. Regulations include: ("E&p waste management," 2011)

##### Rule 317B

- Setbacks and precautions near surface waters and tributaries that are sources of public drinking water

##### Rule 323

- Storage of oil in earthen pits is considered waste. Except for in emergencies or permits.

##### Rule 324 a.

- Pollution. Operators will take precautions to prevent significant environmental impacts. Operators will not violate water quality standards. Operators will not violate Air quality standards

##### Rule 608

- Special requirements for coalbed methane wells. CBM are located close to aquifers because they are shallow wells.

## Colorado regulations continued

### Rule 902e.f.g.h.i

-3 year limit to multi-well pit operation, no unlined pits to fill, no unlined pits close to groundwater, prior treatment of produced water, biocide treatment for bacterial growth and odors.

### Rules 903 & 904

-Pit permitting, lining, monitoring, & secondary containment. Must report within 30 days of construction. Must have emergency response pits.

### Rule 905

- Reclamation

### Rule 906

- Requires COGCC notify CDPHE and the landowner of any spill that threatens to impact any water in the state

### Rules 909 and 910

clean up releases.

### Rules 1003d.

- pit closer
  - croplands- removal of water based bentonitic fluids. Soils must meet requirements. Complete within 3 months. Impermeable barrier
  - non-crop land. All drilling fluids disposed, soil must meet requirements, completed within 6 months

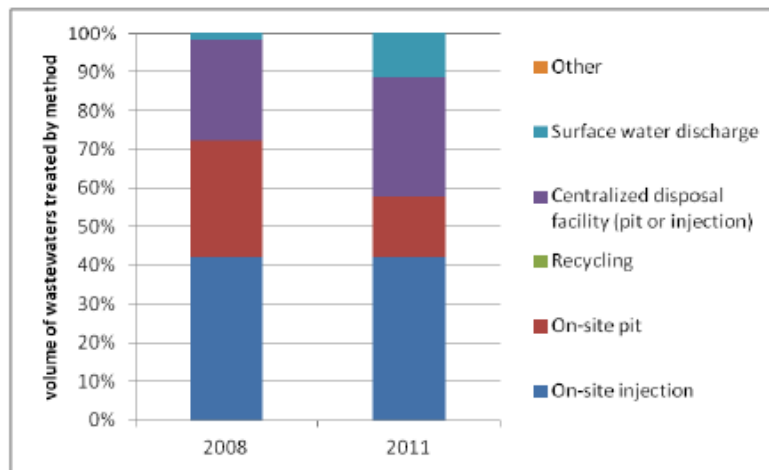
The rules above do not include the subgroups of each rule and is a general overview of the regulations required for pit management and wastewater management.

**Table 2 Produced Water and Disposal Method In La Plata County (Million Gallons)**

Disposal Method	2011	2010	2009	2008	2007	Average
Central Disposal Pit Well	637	1,213	726	646	736	791
Injected on Lease	350	362	175	201	179	253
Commercial Disposal Facility	47	60	61	53	37	52
Onsite Pit	2	2	1	2	1	1
Surface Discharge	NON	NON	NON	NON	NON	
<b>SUM</b>	1,036	1,638	963	901	953	1,098
<b>Percentage</b>	60%	61%	51%	48%	57%	55%
<b>Estimation</b>	1,725	2,697	1,876	1,872	1,874	1,969

(Logan et al, 2013).

Table 3 Colorado Wastewater Treatment Methods



(Logan et al., 2013)

The graphs above indicate how produced water is dealt with in Colorado. Central disposal methods (pit or underground injection) are the main methods of disposing produced water. Surface water discharge has increased since 2008 and there is little evidence of recycling produced water. These practices vary from state to state and there is still a lot of information that is difficult to access by the public, especially in terms of water use, violation statistics, and fraction of water recycled. All of which differentiate from county to county and state to state.

### Violations in Colorado

Compliance and enforcement is crucial for regulatory systems, regardless of the level. Violations in Colorado are reported to the Notices for Alleged Violations (NOAV) and are published publicly. Despite this, it is difficult to access the violation information after 2009. Though Colorado requires that spills and violations get published, it does not provide a user-friendly way to view those violations.

Earthworks states that "September 2011 showed 145 'unsatisfactory' inspections,

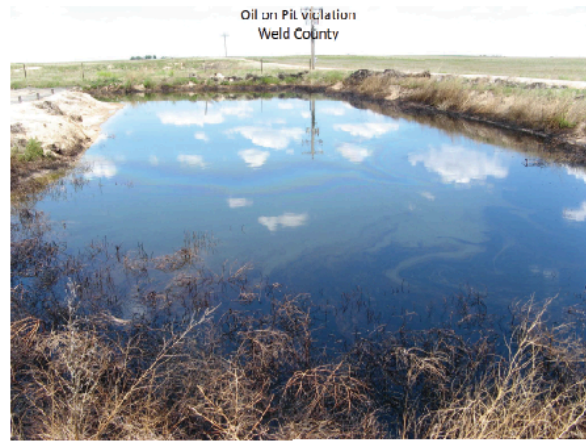
yet only 77 where listed as violations” (“Colorado oil & Gas, earthworks). In Colorado the disposal of produced water is mainly done through disposal pit wells or onsite disposal. Below are some examples of violations and what pits look like.

**Figure 4 Pit violations**

Produced water pit



Oil Pit Violation



("Pit discussion," 2012)

Lining malfunction



Inadequate Pit



("Pit discussion," 2012)



### **Texas Barnett Shale.**

Hydraulic fracturing has occurred for decades in Texas, but in the 2000s, natural gas production exploded in the Barnett Shale region. Horizontal drilling and new innovative technology has allowed oil industries to tap into resources located in metropolitan areas. This differs from Colorado's San Juan Basin in that millions of people live around wells. The Barnett shale was formed during the Mississippian era, which was around 350 million years, as opposed to the San Juan Basin, which was formed 64 million years ago (Smosna & Bruner, 2011). This makes the two formations geologically different. Instead of having a lot of Coal Bed Methane extractions, the Barnett shale has porous sedimentary rock and deeper wells (up to 8,000ft) that have only now been "tappable" due to new technologies (Logan et al, 2013). The shale is the largest formation in Texas and covers a variety of regions over 28,000 sq. miles. Barnett is located across the Fort-Worth area as well as the Bend Arch in North-Central Texas (Smosna & Bruner, 2011).

### **Water Usage**

In Texas, all surface water is managed by the state while groundwater is owned by landowners who have the rights to the water beneath their land, though it is typically managed by Groundwater Conservation Districts (GCDs). The GDC does not require permits for water wells (Galbraith, 2013). The oil & gas industry obtain their water from underground aquifers, specifically the Trinity and Woodbrine aquifers in North-Central Texas (Nicot, 2013). These aquifers are also used in rural areas as well as the Dallas-Fort Worth metropolitan area. Texas water law does not penalize landowners from extracting water, therefore; owners are allowed to extract as much water as wanted regardless of adjacent groundwater depletion.



Water impacts will vary from county to county and depend on local water availability, water use, annual rainfall, rate of extraction, and seasonal changes. As mentioned in the Colorado section, the oil & gas industry is not the number one water user in the state, but the impacts could be damaging to local districts. In some instances, water withdrawals for the industry can reach up to 60% in one region (Nicot, 2013). The combination of high population growth in the Dallas-Fort Worth area, the increased number of wells in the region, and the increased drought that may deplete groundwater sources at a higher rate are the main concerns. The gas industry has even begun using alternatives such as recycling wastewater and using “brackish” water (a combination of fresh and salt water) as substitutes.

#### **Produced Water Management in Texas**

Unlike Colorado, the Texas Railroad Commission does not have rules and regulations specifically to hydraulic fracturing, but do require permits for every step of extraction and disposal processes. The Texas Railroad Commission website makes it much more difficult to find specific regulations on produced water and there is no data on the actual volume of produced water in the Barnett region.

Information was taken from the US Department of Energy as well as Part 1, Chapter 3 of the Texas Railroad Commission ("Produced water management,").

Regulations include: ("Produced water management,")

Rule 3.8 – water protection

Rule 3.46 -fluid injections into productive reservoirs.

Rule 3.47 -allowable transfers from saltwater injection wells.

Rule 3.78 fees and financial security requirements

- Owner and operator receive compensation from others for the storage, reclamation and treatment of oil field fluids/ wastes.

Rule 3.9 (disposal wells)

- Disposal by injection must fill out a W-14 form
- Instruction on records maintenance, monitoring and reporting, testing and plugging
- Consequences of failed compliance

Rule 8 (b)- pollution prohibition of surface or subsurface

Rule 8(d)- prohibition from using an unpermitted carrier or receiver to transport, store, handle, treat, or dispose of produced water.

- A permit to dispose of oil and gas wastes by any method, including pit issued only by the commission determines that the disposal will not result in pollution

Rule 8 (e)—no pollution of Texas offshore or estuarine zones

Spraying produced water onto crops is also not permitted so long as the waste is disposed on the same location as the lease for extraction and toxicity levels are lower than 3000mg/l (Macfarland, 2013). Permitting is required for pits and skimming pits. Most produced water is discharged in deep-well injections.

### Violations

The gas boom in Texas has resulted in a sharp increase in wells that inspectors are now required to oversee. Like every state, Texas now has to respond to the increased demand of inspections. Texas has one of the highest percentages of permitting and reporting violations. For example 32.3% of all wells inspected are not properly permitted or reported ("The crisis in," 2012). There is also little to no

information on violations concerning produced water spills, pit construction and maintenance. The number of inspections has decreased over the years, which has resulted in more undocumented violations. In 2010 there were 88 inspectors and in 2011, nine more inspectors were added, yet the number of wells inspected decreased by 6,245 ("Texas oil & gas," Earthworks). Texas has minor penalties for oil and gas business and the number of violations that are penalized are low ("Texas oil & gas" Earthworks).

### **Pennsylvania**

Texas and Colorado share similar disposal methods due to their history with the oil and gas industry. Pennsylvania is unique in that it does not have the luxury to simply inject produced water in Class II wells. Initially, Pennsylvania attempted to deal with produced water in the state through surface water disposal (Logan et al., 2013). The state attempted to run produced water through wastewater treatment plants and disposed of it in surface water. The produced water quickly overpowered the treatment plants and much of the treated water did not meet federal regulations. As a result, Pennsylvania now recycles 40% of its produced water for well "fracks", which is much higher than other states (Logan et al., 2013).

### **Federal/BLM Regulations**

The Bureau of Land Management (BLM) is a part of the United States Department of Interior and manages public lands. BLM territory is under federal authority and has been around since the birth of the United States. Public lands are used for grazing, wildlife protection, oil and gas exploration, and Native American reservations. As of now, BLM has access to and manages 700 million acres of mineral estate and leases

millions of acres across states for oil and gas exploration ("BLM: Oil & gas," 2013).

BLM has been leasing land for oil and gas exploration for decades. The federal agencies that overlook BLM land include the EPA, NEPA, and the US Department of Interior.

### **Produced Water Management**

Produced water disposal is managed by the Onshore Oil and Gas Order (OOGO No. 7). The regulations were first published in 1993, since then there is no evidence that regulations have been updated to account for the gas boom ("Onshore oil and," 1993).

Regulations include:

**Approval requirements-** no disposal of produced water until approved by an authorized officer

**Disposal methods:** produced water must be injected into the subsurface, lined or unlined pits, or surface discharge under the National Pollutant Discharge Elimination System (NPDES) permits ("Produced water management").

**On-lease and off- lease Disposal Operations-** operators must submit a form in order to dispose of waste or they must obtain an underground injection control permit ("Produced water management").

**Other Requirements:** information requirements for injection wells and pits; requirements for pit design, maintenance, abandonment, and reclamation ("Produced water management").

### Violations

Most information on inspections and violations is gathered by states and is not separated based on federal or state land. All the information in this paragraph will come directly from BLM sources. The only information the website offers on enforcement is that the number of inspections have greatly increased from 2009 to 2011. Note this could also be due to the number of wells that are being put in. The Most information on inspections and violations is gathered by states and is not separated based on federal or state land. All the information in this paragraph will come directly from BLM sources. The only information the website offers on enforcement is that the number of inspections have greatly increased from 2009 to 2011. Note this could also be due to the number of wells being put in.

### Coastal Zones (federal regulation)

The Gulf of Mexico is considered federal jurisdiction and is monitored by EPA Region 6 under the Coastal Zone Management Act (CZMA). The EPA issues permits under the National Pollutant Discharge Elimination System (NPDES) that authorizes discharges from exploration and development into the federal waters of the Gulf of Mexico ("Final npdes general," 2004). Produced water east of the 98<sup>th</sup> Meridian in Texas, whose toxicity levels do not exceed 25mg/l monthly average and 34mg/l daily maximum can be discharged ("Final npdes general," 2004).

### Produced water regulations

- a) Permittees who wish to discharge produced water can increase mixing through the use of a diffuser, adding sea water, or installing multiple discharge ports ("Final npdes general," 2004).
- b) Permittees that wish to reduce the discharge rate must provide the EPA with a description of the specific changes ("Final npdes general," 2004).

### Monitoring requirements

- a) Flow must be monitored once a month and recorded in units of barrels per day ("Final npdes general," 2004).

### Toxicity testing

<u>Discharge Rate</u>	<u>Toxicity Testing Frequency</u>
0 - 4,599 bbl/day	once per annual DMR monitoring period
4,600 bbl/day and above	once per calendar quarter:

### Enforcement

- a) The permittee must inform the director within a reasonable time if there is a violation. The permittee will also, upon request, give over copies of records required under the permit ("Final npdes general," 2004).
- b) Concealment of information or misleading information can result in criminal prosecution ("Final npdes general," 2004).

### Summary

This section will exhibit the wide variation between states in terms of information available as well as different approaches to enforcement and violations.

Texas: Texas Railroad commission does not have publicly accessible databases on violations

Colorado: COGCC does have violations but they are hard to obtain and usually only go back a year.

Colorado's violation trends are hard to follow because not all violations are reported to the NOAV (Notices of Alleged Violations) while Texas trends show a decreasing number of violations.

Federal: No data

## Tables

All of these graphs were taken from earthworks ("The crisis in," 2012). Colorado yields no data due to the fact that not all violations are reported to the NOAV. Texas has a significant number of violations. Note this could be because of increased inspections and higher number of wells.

Table 4 Violation Data by State

State	Violations	Inspections	Violations found per inspection	Notes
Colorado	No data	16,228		319 Notices of alleged violations
New Mexico	No data	20,780	÷	418 Letters of violation
New York	No data	2,460	No data	No data
Ohio	1,094	10,472	0.10	Violations
Pennsylvania	2,704	16,199	0.17	Violations
Texas	71,646	121,123	0.59	Violations

Table 5 State-by-state Comparisons of Inspection Staff and Activity (2010)

State	Inspectors	Inspections	Inspections per inspector
Colorado	15	16,228	1,082
New Mexico	12	20,780	1,732
New York	16	2,460	154
Ohio	21	10,472	499
Pennsylvania	65	15,368	236
Texas	88	121,123	1,376

The graph above represents the number of inspectors to inspections. Data shows wide variation in inspections per inspector ("The crisis in," 2012).

The graph below demonstrates the variation in penalties per state. ("The crisis in," 2012)

**Table 6 Civil Penalties for Violations of Oil and Gas Regulations State**

State	Maximum penalty	When maximum penalty is applied
Texas	Max \$1000 - \$10,000 for each day violation continues	Amount depends on rule that is violated. Largest penalty only applies if the provision, rule, or order pertains to safety or the prevention or control of pollution
Ohio	Max \$2,500 – \$20,000 per each continuing day of violation	Amount depends on which section of Code is violated. Largest penalty primarily applies to rules to prevent pollution from extraction, storage and injection of brine, oil, natural gas or other fluids.
New Mexico	Max \$1,000 for each day violation continues	Applies to anyone who knowingly and willfully violates the Oil and Gas Act
New York	Max \$8,000 per violation plus \$1,000 - \$2,000 for each day violation continues	Applies to violation of Article 23 or any regulation, order or permit condition.
Colorado	\$500 - \$1,000/day that violation continues	Maximum total fine for violations that do not have adverse effects on public health/welfare/resources is \$10,000 regardless of # of days of continued violation. For violations that affect public health/welfare/resources the total may exceed \$10,000.
Pennsylvania	\$25,000 per violation plus \$1,000 for each day violation continues (conventional wells) and \$75,000 per violation plus \$5,000 for each day (unconventional well)	Applies to violations of Title 58 Oil and Gas.

## Chapter 4: Tradeoffs and Conclusions

In the research process there were many contradictions or lack of information that made it difficult to reach solid conclusions. Finding scientific evidence that hydraulic fracturing was the source of environmental damages was surprisingly difficult. This section will address critiques to theories at the state and federal level and scientific evidence for environmental impacts.

### Under regulation and overregulation

States are often accused of under regulating the oil and gas industry and the federal government of over-regulating. Under regulation has the potential to cause environmental externalities that could be serious while overregulation can be unnecessary and costly. Some states are known for being industry-biased and pro energy development. At the same time, other states have been regulating the oil and



gas industry for decades and in some cases at least 100 years, and it would be overstated to say that some of those states have never done an adequate job. In contrast, the federal government has made water protection a national issue and has been successful in protecting the nations' environment as well as protecting local communities from contamination. It is evident that the creation of the SDWA and the CWA were responses to state failure (Spence, 2013). A state-failure industry example is the Surface Mining Control and Reclamation Act (SMCRA) of 1977. In this instance the states failed to protect the local communities from coal industries and the federal government had to step in and provide minimal standards to which states must adhere. States argue that this does not apply to fracking because mining had very clear environmental damages (Spence, 2013).

### Scientific evidence

To the public, it appears that the states have struggled to keep up with the gas booms, and in some senses this is true. Currently, many NGOs and environmental groups are conducting research on the health effects of fracking. The EPA will release their second report in 2014, which will reveal if there is a need for more federal regulation. Researching the environmental impacts on fracking was challenging; the majority of peer-reviewed articles had a disclaimer in their conclusions that stated, "more research is needed," which does not prove that there are significant environmental impacts, but it does not prove that there are not. Future study in the matter could conclude substantial environmental impacts. From published scientific research, it appears that there is evidence of environmental damages, but there has been no documented proof for large-scale, serious damages.

For example, a recent study sampled 160 flowback wells in Pennsylvania's southwest and northeast region. The study concluded that in the southwest region, there were higher levels of calcium, magnesium, and bromide than in the northeast region (Barbot et al., 2013), while the northeast region there were higher levels of barium and strontium (Barbot et al., 2013). All of these chemicals are found in produced water. The study is intended to help in wastewater management, but it mentions nothing of environmental damages. Another report analyzed the impacts of radioactive waste from produced water against marine biota. The study analyzed different reports on produced water and radioactive contaminations. According to this academic article:

Although almost all of the studies considered in this review indicate that the risk to the environment from naturally occurring radionuclides discharged in produced water is negligible, there are substantial uncertainties in the reported estimates of impact and further research is required (Hosseini et al., 2012).

This concludes that there are many gaps within academic journals.

The media plays a big role in the environmental debate. In 2010, the EPA issued an emergency order in the Barnett region after it determined that natural gas was the cause of water contamination in Parker County (Hawes, 2010). This was the first time that the EPA publically claimed that water contamination was due to hydraulic fracturing in the Barnett region (Hawes, 2010). The claim was dropped after a 15-month investigation, once the EPA was unable to prove that the Methane levels were due to hydraulic fracturing (Pyle, 2012). A similar story is occurring in Wyoming. In the case of Wyoming, the EPA has been accused of releasing reports that are not peer-reviewed and have used unsound scientific methods (Pyle, 2012).

In contrast, the EPA does not need to have peer-reviewed scientific methods because it is not for journal publication. It is not that there is no methane contamination, but whether or not it can be linked to fracking is the difficult part. More stringent peer-reviewed research needs to be done in order to determine if hydraulic fracturing is the cause of significant environmental contamination. As of now, there is no proof that fracking has caused extensive environmental damage (to the point of federalization), but there is also no proof that fracking has not caused extensive environmental damages.

### **Findings and Recommendations**

This report analyzed whether hydraulic fracturing should be federalized or remain at the state level, particularly looking at produced water regulations in Texas, Colorado, and BLM land. The paper also compared pro-state and pro-federal arguments and a hybrid approach to regulating hydraulic fracturing is recommended. Though both states have extensive experience regulating oil & gas industries, the fragmentation between gas producing states in terms of violation statistics, inspection variation, and public access to information suggests that an increased federal presence would be beneficial. On the other hand some states are changing legislation to keep up with public concerns and environmental threats. Regulating a changing industry with huge regional differences (topography, frack fluid, and economic needs) is challenging and full federalization could be costly and inefficient. Much of public concern and distrust in the natural gas industry comes from lack of information available to the public, which is the basis of most of the

recommendations. Below are recommendations deduced from the report. The SEAB 2011 report provided guidance for the last two recommendations.

#### State Recommendations

- Violations and enforcement vary significantly from state to state. It was difficult to find information in both Colorado and Texas. Violations in Colorado resulted in no data, federal entities resulted in no data, and earthworks provided data for Texas (but the RRC does not have publically accessible data on violations). It was also difficult to determine whether or not increased inspectors or cases of violations had to do with the huge jump in well installments or lack of regulatory resources and compliance. Public concern has been steadily increasing ever since the gas boom and there needs to be a better system for public access and industry transparency. States should create databases that are user friendly and accessible on their websites (COGCC and RRC).

#### State and Federal Recommendations

- Finding information on produced water regulations proved to be difficult at every level. It was much more difficult to find regulations in Texas than in Colorado. I was also unable to find any data on violations or enforcement in both federal data collection scenarios (BLM or Coastal regulations). Both the federal government and state regulators should find any easier way for the public to access permit information. Once again this is a transparency issue.

#### Recommendations for Federal Oversight

- The number of inspectors per well varied greatly between states. Evidence in the summary section. Implementing a minimum number of inspectors per well would increase monitoring capabilities. It is important to note that different counties and states have different funding capabilities and may not be able to support more inspectors. One option could be to charge permitting fees to industries for funding.
- Produced water that is discharged into surface or underground water sources that cross state boundaries, should be regulated by the federal government or interstate compacts. The compacts should also be reviewed at the federal level.
- Recycling programs that reuse frack water for hydraulic fracturing should be required for every state. This would help with water management in areas with shortages and help protect the environment.

#### General Recommendations

- There needs to be more academic research on the environmental impacts of hydraulic fracturing. Water quality should be tested before and after gas extraction to find the source of contamination if present (e.g. Methane levels) (SEAB, 2011)
- Use the STRONGER (the State Review of Oil and Natural Gas Environmental Regulation) program. STRONGER is a non-profit, multi-stakeholder organization that created a program to review states on their regulatory progress. All states can participate voluntarily, in 2011 Colorado participated in a HF review but Texas has not (though Texas has participated in an initial

and follow-up review- in 2003) (STRONGER, 2013). This will also allow the public to see how their states are performing in terms of environmental protection and regulatory compliance.

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